The form of organic matter in the muddy sediments near Eckernfoerde Bay, Germany

by

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1. Introduction

Organic matter (OM) is one of the most important components in the seafloor sediments in Eckernfoerde Bay, Germany. The OM accounts for up to 10 weight % of sediments in some parts of the Bay. Because OM is relatively low in density and often hydrophilic, its role in defining the sediment structure and microfabric can be significant. Therefore, it is important to understand the form of OM in the sediments.

This study was originated under the hypothesis that the OM is either incorporated into the fecal pellets which are abundant in the study area sediments, or coating the surface of sediment particles. The clay-sized particles would provide the most surface are for the OM coating due to their large specific surface area.

In order to test the above hypothesis, the relationships among OM contents, fecal pellet contents, and clay contents were examined.

2. Methods

The sediment samples were obtained during the Coastal Benthic Boundary Special Research Program (CBBL-SRP) Eckernfoerde Campaign using box and gravity cores. The sediment microfabric samples were obtained and prepared using the method detailed in Lavoie et al. (1996). Some of the sediment samples were kept frozen until the time of total organic carbon (TOC) analysis. The OM contents were represented by the TOC values. TOC was analyzed using Rock-Eval method at Humble Geochemistry, Humble, Texas. The sediment samples were analyzed for various index properties including the grain size using the Folk method (Folk, 1974) at the Naval Research Laboratory by Dr. Dawn Lavoie .

After embedded in epoxy, the microfabric samples were polished, carbon coated, and observed under a scanning electron microscope (SEM). Triplicate SEM photographs were taken at the magnification of approximately x100 for each sample, and were digitized for the subsequent image analysis. Each photograph was visually examined for fecal pellets. The pellets were then painted and the ratio of the numbers of painted pixels to total pixels was determined using Image Tool, an image analysis program.

3. Results

The TOC values of the gravity cores P1 and P3, and box cores 634, 652, 658, 662, and 663 are shown in Figure 1. The grain size distribution is shown in Table 1 (Dawn Lavoie, unpublished data).

An SEM image of P1-30 cm below sea floor (bsf) is shown in Figure 2. The pellets were painted as shown in Figure 3. The volume % of pellets estimated by the painting of pellets are shown in Figure 4 for the samples from gravity cores P1 and P3.

4. Discussion

TOC vs. Pellets

Figure 5 shows the relationship between the TOC values and pellet volume %. There is little correlation between the two variables indicating that the OM may not be preferentially incorporated into fecal pellets.

TOC vs. Clay Content

Figure 6 shows the relationship between the TOC values and clay content. There is a very strong positive correlation between the two variables. The strong correlation may be explained by the coating of OM around clay particles due to their large specific surface area. It may also be due to the faster OM oxidation in less muddy sediments where permeability is high and the electron acceptors (e.g., O_2, SO_4^{2-}) are supplied more readily.

5. Further study

In order to determine the form of OM in sediments, more microscope work is necessary. In order to preserve OM in microfabric samples, freeze drying, rather than fluid exchanging, may be necessary as the fluid exchange may dissolve or alter OM.

Because fecal pellets are often very important components of sediment structure and microfabric as seen in Figures 2 and 3, their effect on sediment geophysical properties need to be examined.

6. References

Folk, R. L. (1974) Petrology of Sedimentary Rock. Hamphill Publishing Company.

Lavoie D. M., Lavoie, D. L., Pittenger, H. A. and Bennet, R. H. (1996) Bulk sediment properties interpreted in light of qualitative and quantitative microfabric analysis. GeoMarine Letters. in press.

Table 1. Grain size distribution of samples from gravity cores (P1, P2) and box cores (634, 652, 658, 662, 663). The data set is provided by Dr. Dawn Lavoie (unpublished data).

Core ID	Depth (cm)	sand (weight %)	silt (weight %)	clay (weight %)	Mean Grain Size (ϕ)
P1	30	1.39	81.53	17.06	7.35
	65	1.35	83.13	15.51	6.89
	75	0.66	78.97	20.35	7.42
	85	0.83	78.35	20.81	7.56
	98	1.02	81.48	17.48	7.52
	108	0.95	78.84	20.20	7.56
	119	1.69	76.43	21.87	7.67
	129	1.34	78.74	19.90	7.63
	143	0.87	47.40	51.71	8.39
P3	64	0.92	74.14	24.93	7.51
	75	1.53	77.00	21.45	7.22
	81	1.14	75.63	22.95	7.66
	102	0.42	77.08	22.49	7.69
	117	0.63	77.92	19.45	7.59
	128	12.01	66.24	21.74	7.34
	135	0.74	75.70	23.54	7.80
634	top	4.63	53.71	41.64	7.16
	middle	5.98	80.20	13.80	7.05
	bottom	6.96	76.33	16.69	7.16
652	top	78.14	19.41	2.44	4.08
	middle	84.88	13.45	1.66	3.65
	bottom	89.13	9.41	1.45	3.41
658	top	72.27	24.19	3.52	3.85
	middle	75.69	21.13	3.17	4.08
	bottom	79.16	18.10	2.72	3.75
662	top	21.06	65.22	13.71	6.23
	middle	43.48	52.91	3.59	4.66
	bottom	61.62	31.83	6.54	4.56
663	top	20.31	61.38	18.29	5.74
	middle	28.27	66.49	5.22	4.96
	bottom	23.55	62.03	14.40	6.01

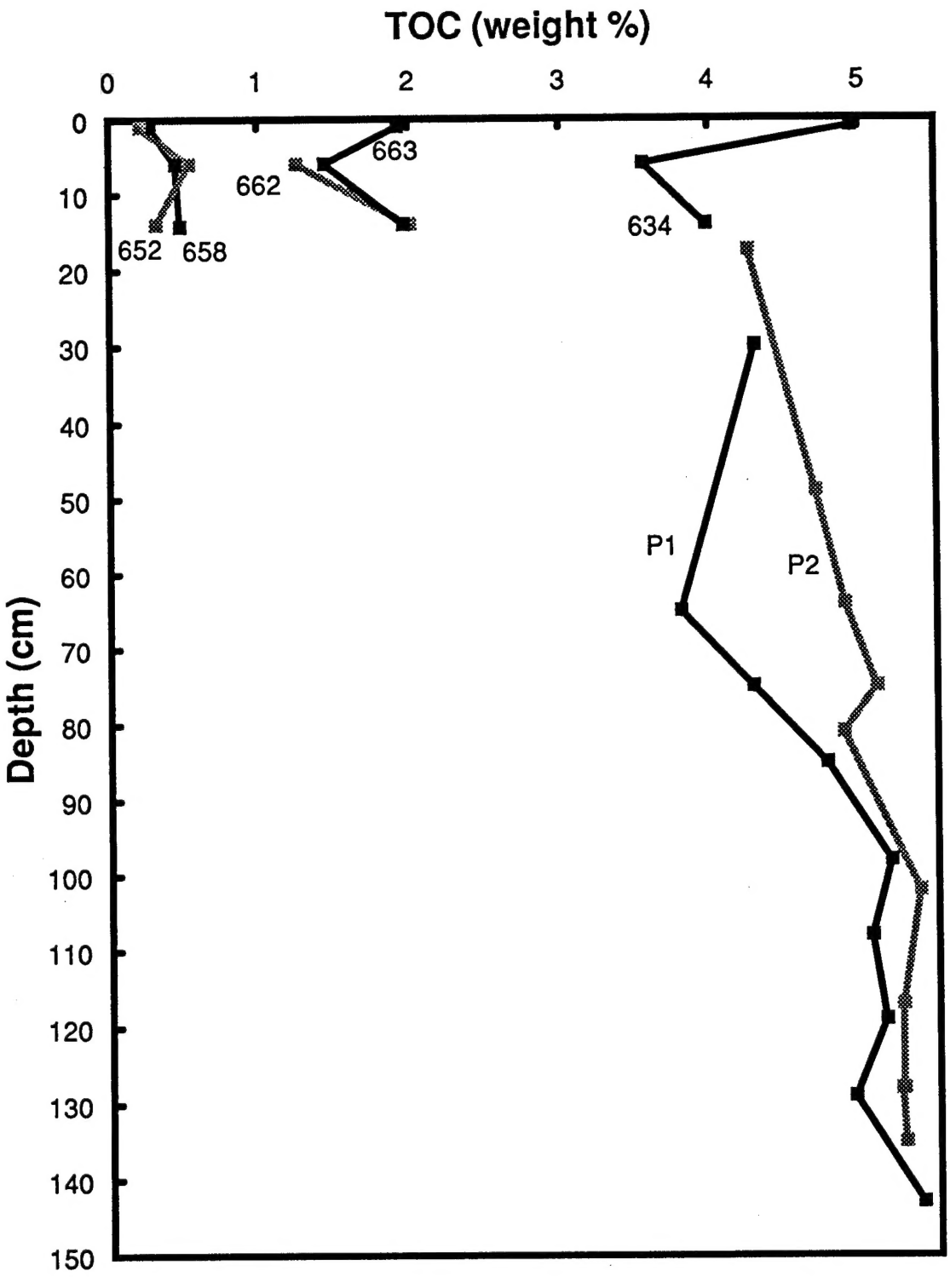

Figure 1. The depth profiles of TOC values.

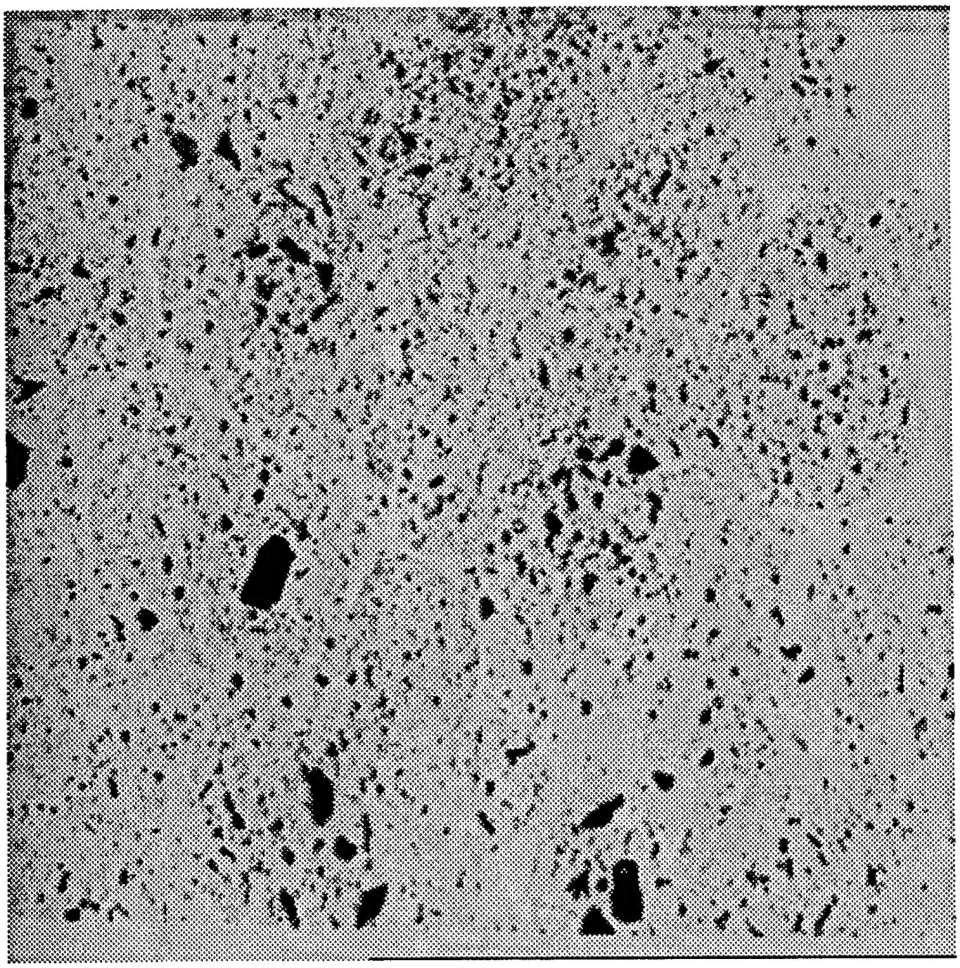

Figure 2. An SEM image of a pellet-rich sediment sample (P1-30 cm bsf).

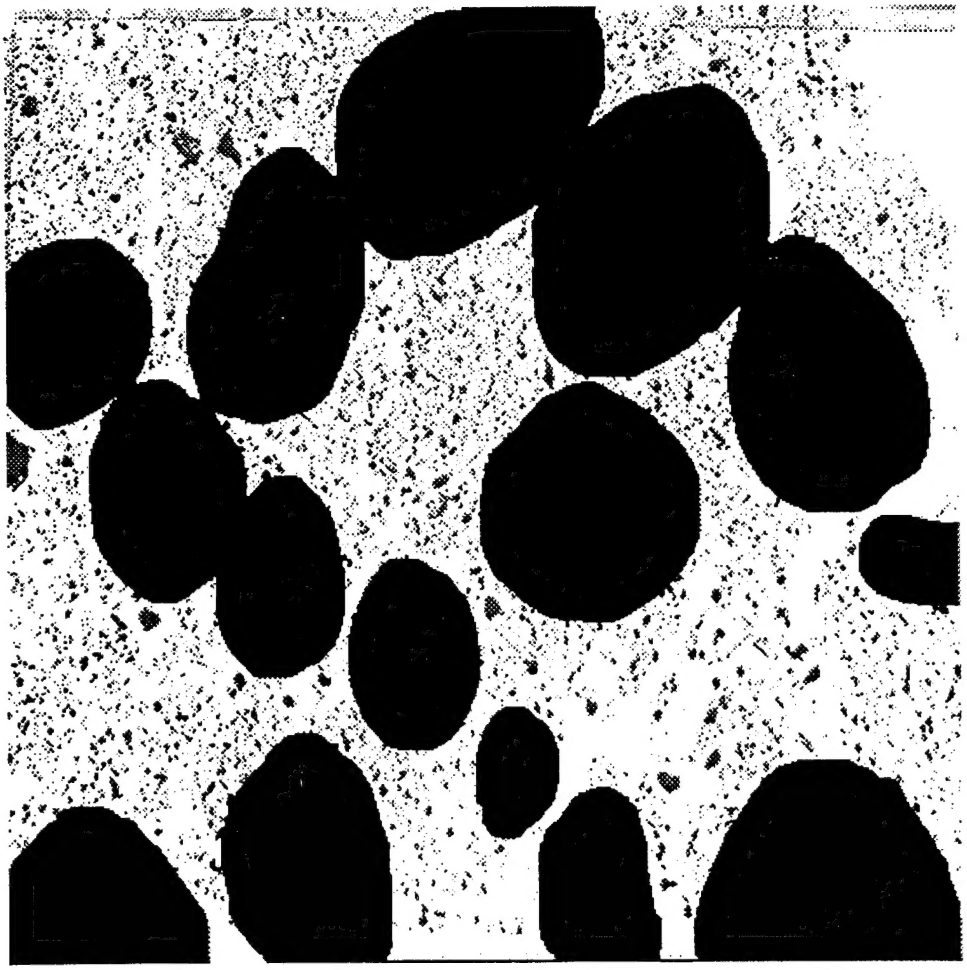

Figure 3. The same view as Figure 1 with the painted pellets.

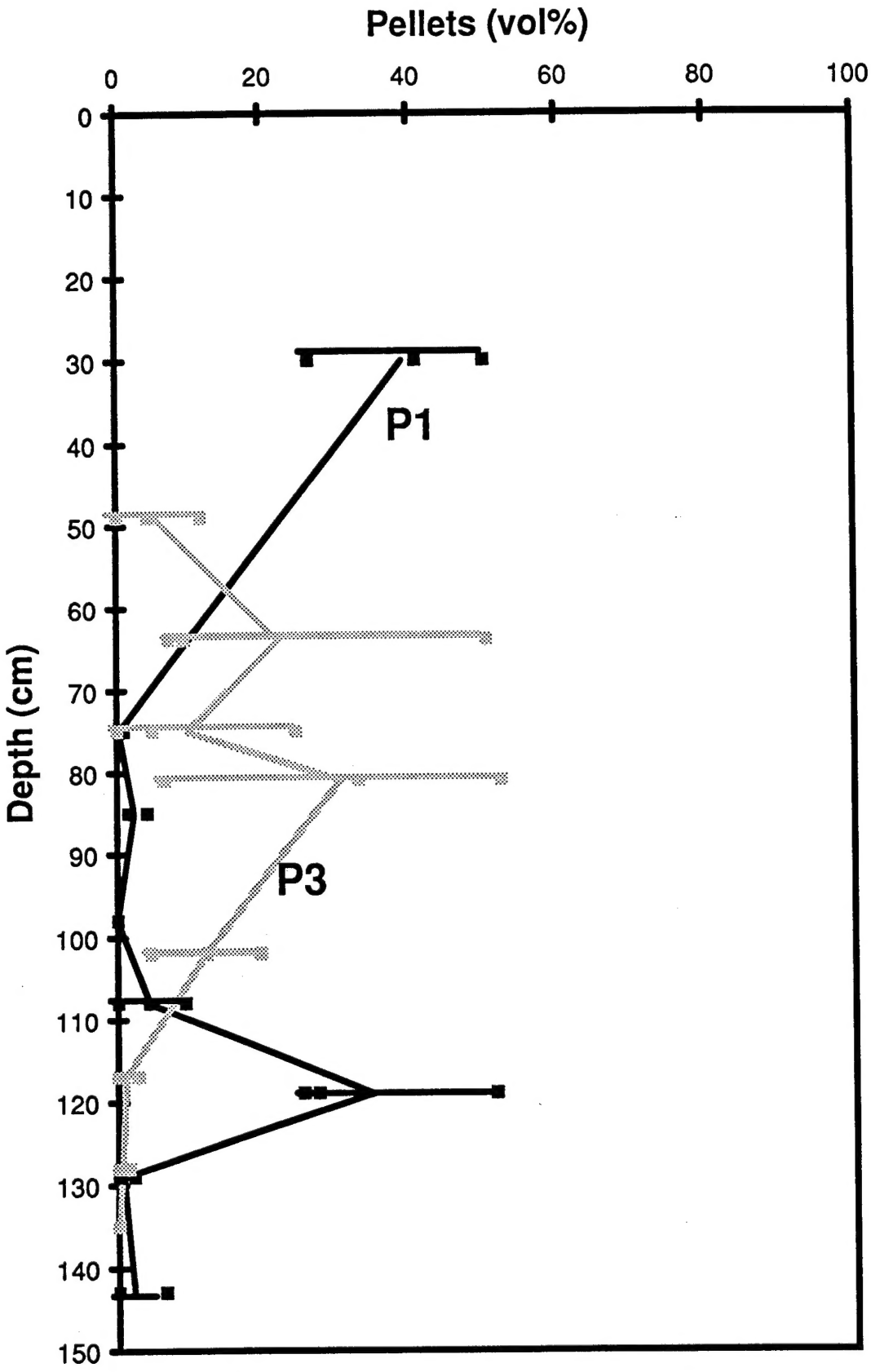

Figure 4. The depth profiles of fecal pellet contents.

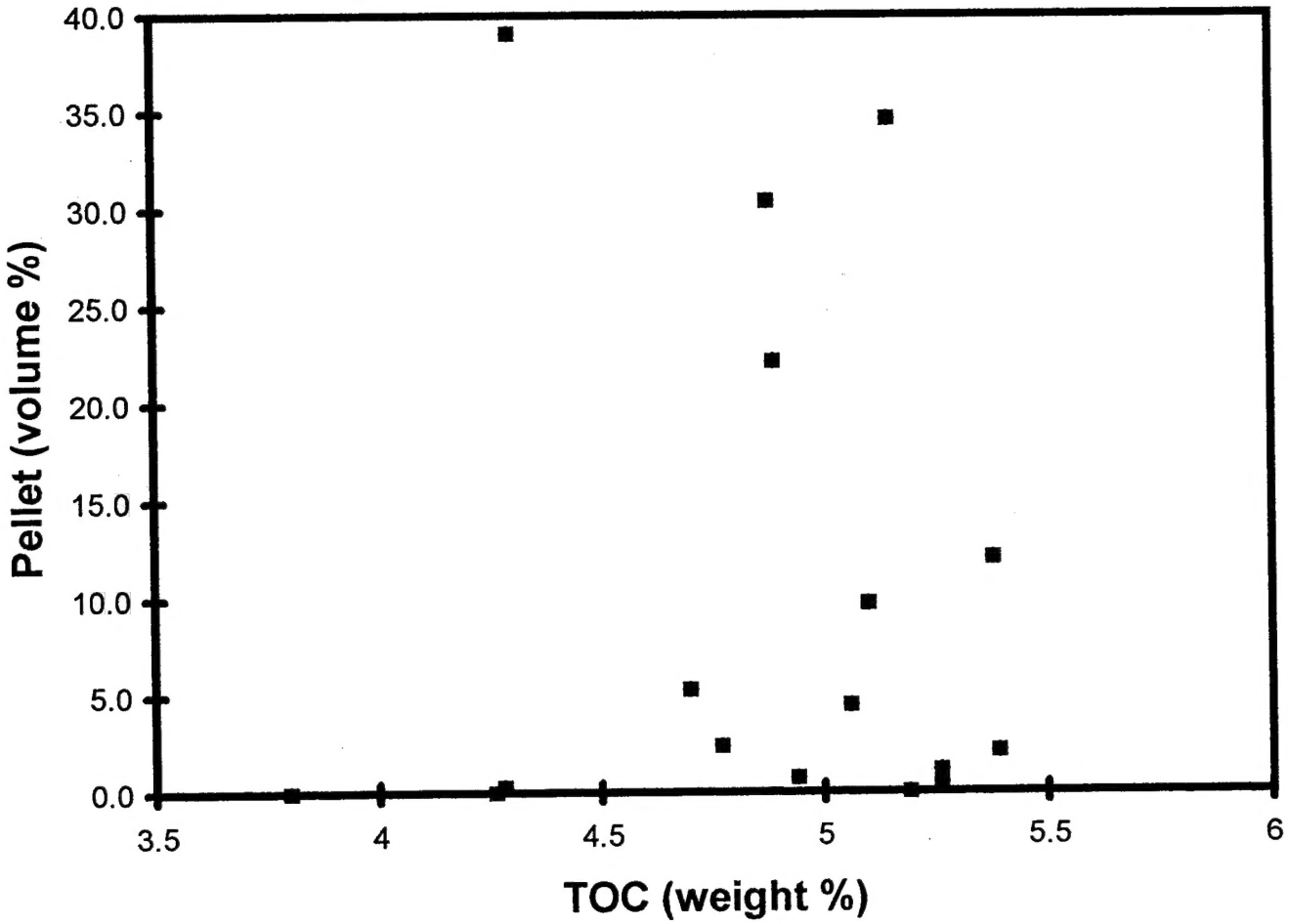

Figure 5. The relationship between the TOC values and fecal pellet content.

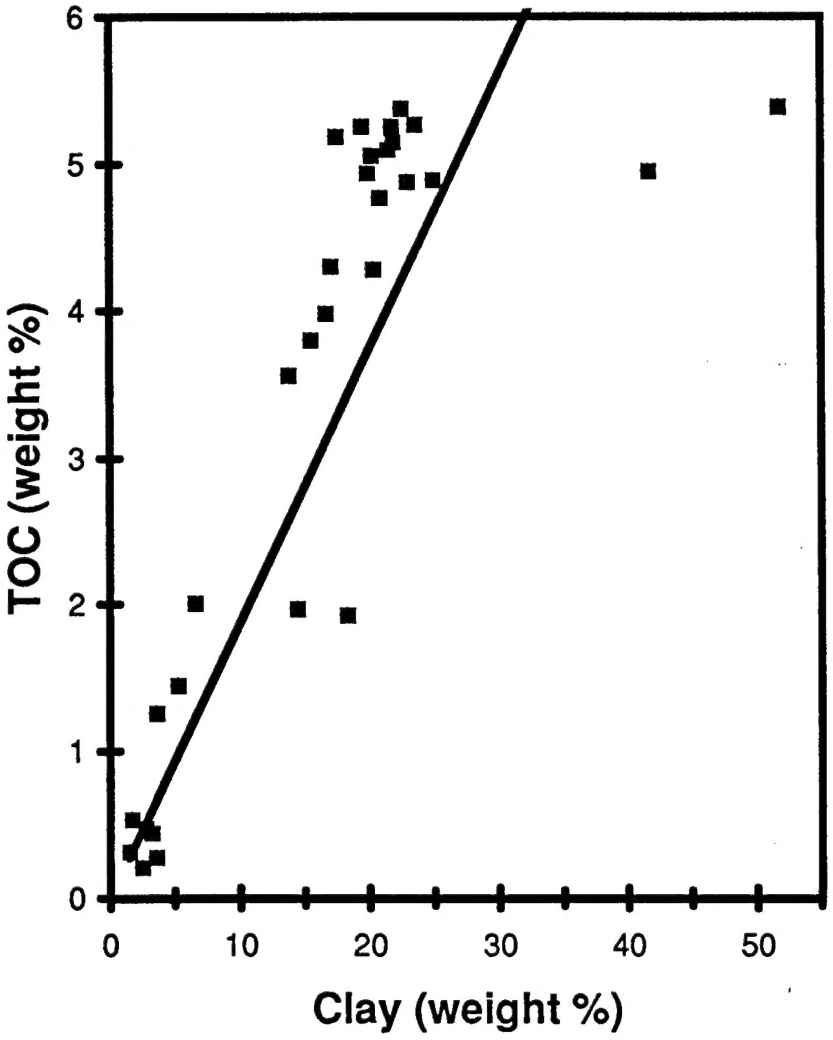

Figure 6. The relationship between the amount of clay-sized particles and total organic carbon (TOC).

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The organic matter contents in the seafloor sediments from Eckernfoerde Bay, Germany, is positively correlated to the available specific surface area of the sediments. This may be attributed to the organic matter coating of sediment particles.

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